Underwater Intelligent Sensor Protection System

Peter J. Stein, Armen Bahlavouni
Scientific Solutions, Inc.
99 Perimeter Road, Nashua, NH 03063
Phone: (603) 880-3784, Fax: (603) 598-1803, email: pstein@scisol.com

Contract Number: N00014-99-C-0226

LONG-TERM GOAL

The long-term goal is to develop an Underwater Intelligent Sensor Protection System (UISPS) to keep underwater radiometers free of algae growth and other contaminants. UISPS will allow long-term autonomous radiometric measurements (in the order of one year), which are not currently possible.

OBJECTIVES

The objectives of this program were the design and assembly of the prototype, perform preliminary testing in laboratory, debug the system as necessary, and perform testing in an ocean environment.

APPROACH

One of the important limiting factors in carrying out long-term measurements underwater is the bio fouling that accumulates on the instrument and corrupts the data. Our approach to designing an instrument capable of long-term measurement is to periodically clean the instrument's sensor window. The cleaning itself is accomplished by mechanical means. The instrument is taken through a cleaning cycle periodically. The logic of the measurement and cleaning cycles is controlled by an on board computer. This provides a means of varying the frequency of the cleaning cycle. The computer also controls the data acquisition.

Figure 1 depicts an assembly drawing of the system. This device consists of a two-part spherical housing of which the lower portion houses the radiometer. The upper portion consists of an optical glass that completes the sphere. The spherical volume between the radiometer head and the glass dome is filled with a clear saline solution in order to keep diffraction to a minimum. This volume is also compensates for pressure and temperature changes in order to minimize stresses on the glass dome. The composite sphere rotates within a circular aperture/scraper, which is in the immediate vicinity, but does not touch the sphere. The sphere and the scraper are attached to a cylindrical shell. As the sphere rotates past the scraper, the bulk of the contaminants are removed. Continuing the rotation brings the optical window (and the rest of the sphere) into a bath of cleaning solution and past a set of brushes and squeegees within the cylindrical shell. An o-ring seal within the scraper isolates the cleaning solution from the exterior seawater. The cleaning cycle is complete when the sphere completes one full revolution and the optical glass reaches the 12 o'clock position again.

The drive enclosure consists of a simple chain drive mechanism driven by a DC gear motor for rotating the sphere. A planetary gear head is chosen for its inherently low lubrication and maintenance

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2001**	2. REPORT TYPE	3. DATES COVERED **00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE **Underwater Intelligent Sensor Protection System**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Scientific Solutions, Inc.,,99 Perimeter Road,,Nashua,,NH, 03063**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The long-term goal is to develop an Underwater Intelligent Sensor Protection System (UISPS) to keep underwater radiometers free of algae growth and other contaminants. UISPS will allow long-term autonomous radiometric measurements (in the order of one year), which are not currently possible.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**6**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

requirements. All dynamic seals and bearings are self-lubricating to minimize service and maximize system life.

The electronics enclosure consists of a computer, an interface board, a mechanical limit switch, and a slip ring. The limit switch is used to position the sphere at its measuring position. The slip ring carries the electrical signals between the rotating sphere and the stationary interface board. The frequency of cleaning, number of rotations per cleaning cycle, data sampling rate and frequency, and all other data acquisition and control parameters are adjustable for greater flexibility of the device. A bi-axial inclinometer has also been implemented within the sphere to provide reference tilt data. The system is able to collect data in a self-contained mode, powered internally by a 12-volt battery. Alternatively, a cable connection is also provided so the data and power can be streamed to a central computer should the system be deployed as part of an instrumented mooring.

WORK COMPLETED

The work completed this fiscal year consists of:

1. Testing/debugging software for proper data acquisition and control.
2. Test and debug hardware/software interface.
3. Testing of complete assembly in the laboratory.
4. Measurement of the sensitivity of the radiometer with and without the glass dome.
5. Test deployment off the dock at the Woods Hole.

During the next year we will be making some modifications to the equipment due to results from the WHOI deployment and implementing a long-term deployment.

RESULTS

Figure 2 shows pictures of the sensitivity measurements, while Figure 3 shows the results. The glass dome which covers the radiometer has a negligible effect on sensitivity up to in-air incidence angles close to grazing.

The device was deployed off the WHOI dock for about one week. On retrieval the rotating sphere was half opened and jammed in that position. The motor chain was found broken. It appears the device jammed due to corrosion build-up at the glass sphere to metal dome seal. However when retrieved, the entire device was covered with biofouling; the glass sphere was much cleaner. Thus the conclusion is that while it was working the device was accomplishing its task of keeping the glass dome clean.

Modifications to the system will be made next year to eliminate the corrosion problem and also add motor controls that will reverse direction and then stop if jamming occurs. We also think replacing the metal scraper with a hard rubber scraper will eliminate problems should small particles get in between the dome and the scraper.

IMPACT/APPLICATIONS

This system will considerably enhance the quality of the underwater radiation measurements and reduce hardware maintenance costs by keeping the sensor clean and free of biological growth. Furthermore, the longevity of measurements will be greatly improved in comparison to current deployments.

RELATED PROJECTS

During the deployment phase of the SHEBA program in September 1997, SSI personnel deployed eight of the Arctic ISPS units in satellite sites as far as 50 Km from the main ice camp [1]. These units worked flawlessly for one full year, as intended. In October 1998, they were recovered, and one site re-deployed. Further information and deployment photographs are available on SSI's web page [2].

A marine version of the ISPS has also been developed under ONR Contract #: N00014-95-C-0406. This version is intended to be integrated into the Navy's next generation meteorological sensor package.

REFERENCES

1. "Intelligent Sensor Protection System for Polar Environments", Peter J. Stein, Armen Bahlavouni, Douglas W. Andersen, Sea Technology, pp 62-66, February 2000.

2. http://www.scisol.com

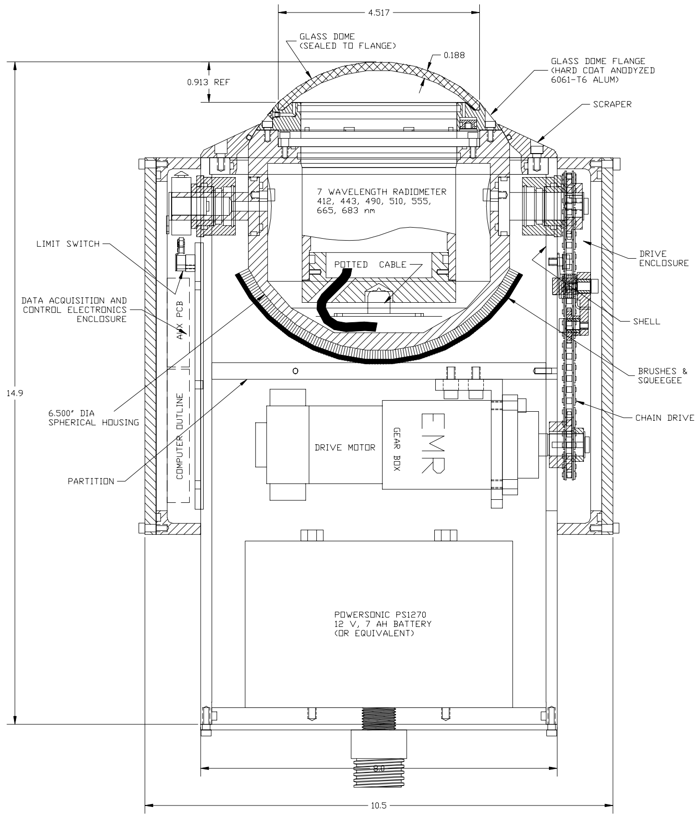

Figure 1. UISPS Assembly Drawing Patent Number: 5,591,907 dated 1/7/97).

Figure 2. Pictures of the radiometer sensitivity test made in the SSI test tank. Measurements were made with the device below water level and a light source in air. The output of the 7-wavelength SATLANTIC radiometer was recorded as a function of in-air light incidence angle. Measurements were made with and without the glass dome of the ISPS covering the radiometer.

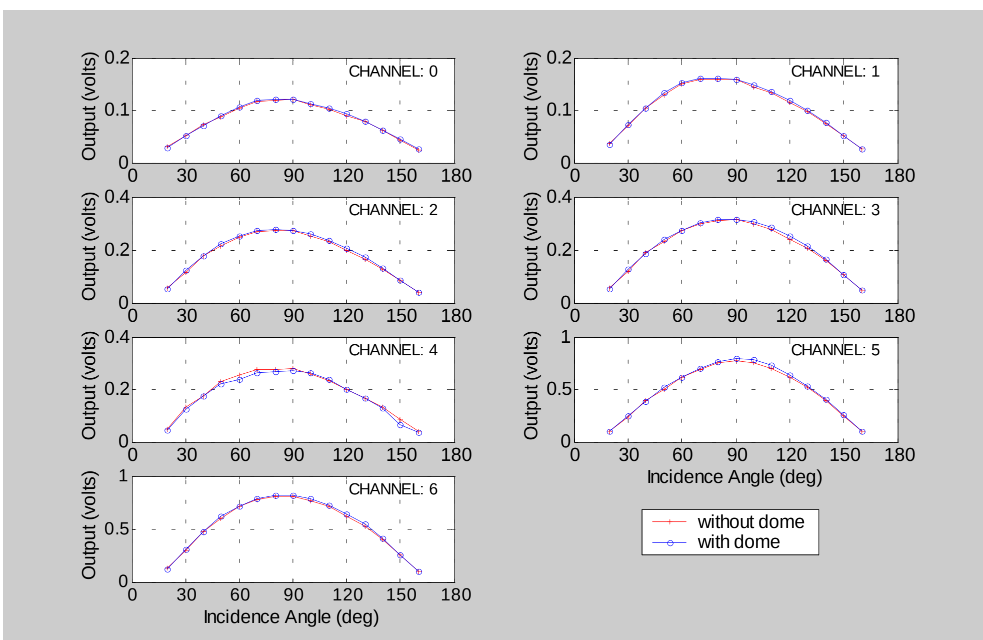

Figure 3. Results of the radiometer sensitivity test. These show no change in sensitivity with and without the dome for in-air incidence angles up to 75 degrees.